

A single frequency, fiber ring laser in Yb:silica

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We have designed and operated a tunable source for applications where a shorter pulse will be chopped from a long Q-switched pulse by electro-optic modulators, then amplified in Nd:phosphate glass.

The laser employs ytterbium-doped silica fiber as the gain medium, pumped by a laser diode at 980nm. Gain in Yb:silica is distributed over 90nm range, making it suitable for operation at many wavelengths (1). Our previous experiments with this medium demonstrated oscillation over a 50nm wide band (2). In addition, pumping at 980nm allows the use of stable pump diodes used in erbium-doped fiber amplifiers (EDFA's). To take advantage of this wideband gain medium, and yet operate on a single cavity mode, we designed the laser of figure 1.

A circulator causes unidirectional operation, and allows use of a fiber grating in reflection. This grating has a 0.2 Angstrom bandwidth, and defines the coarse tuning of the laser. It is piezoelectrically stretch tuned to the desired wavelength band (3). A single mode of the cavity is selected by a piezoelectrically tuned fiber grating Fabry-Perot etalon with 64MHz bandwidth.

The laser is Q-switched by a bulk acousto-optic device at 1kHz repetition. The loss is controlled to allow the oscillator to lase close to threshold for 500 μ s before the Q-switch is turned off completely, creating a pulse (see figure 2). This "pre-lasing" stabilizes the single mode, since the Q-switch pulse builds up from the pre-lase level (4).

To prevent mode hopping during long term operation, the cavity length is feedback controlled. Another piezoelectric device stretches a fiber in the cavity according to the sum of a dither signal and an error signal from a lock-in amplifier.

Due to the long, high loss cavity, the Q-switched pulse is about 1 μ s long. We are currently fusion splicing the components to reduce cavity length and connector losses.

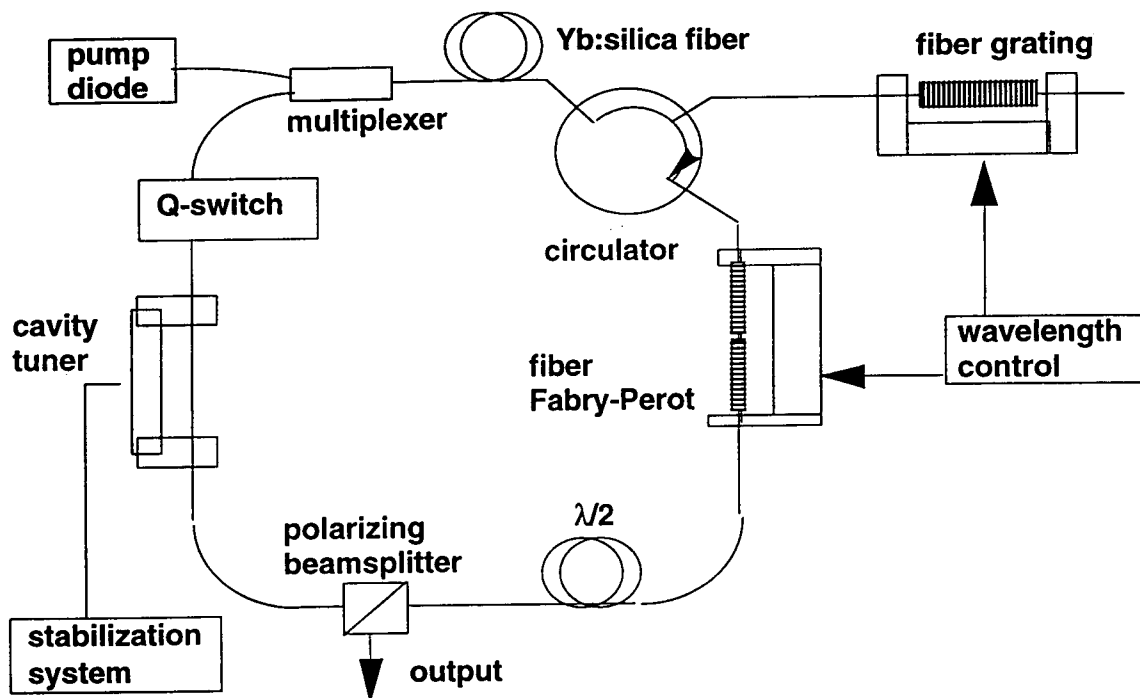


Figure 1. Fiber ring laser optical schematic.

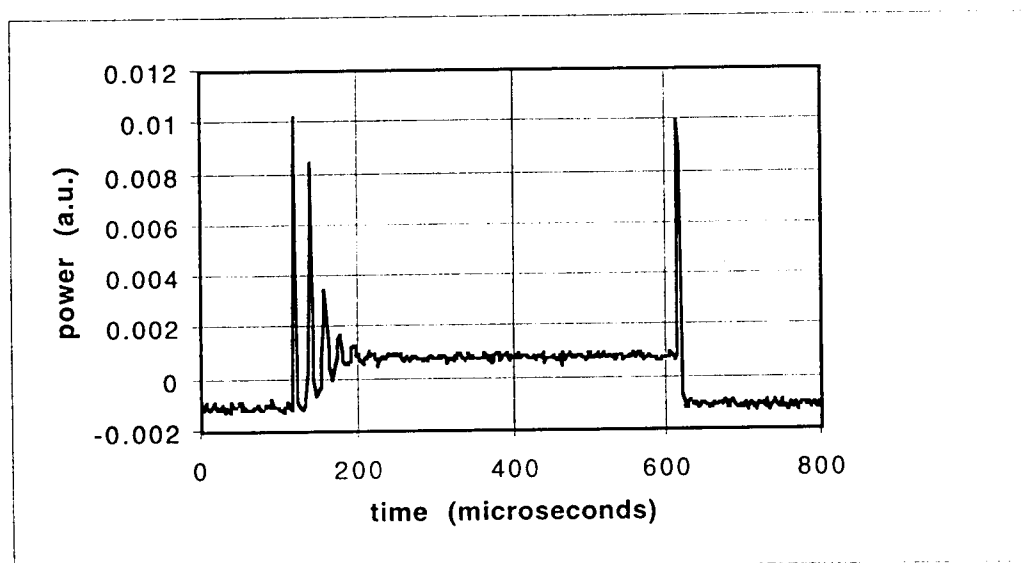


Figure 2. Optical power in laser cavity during stabilization period before Q-switching. Note dampened relaxation oscillations at start.

References

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